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it would be of great interest to ascertain their relation to the other remains. Let us trust that ere long there may again be a season in France when a thought may fairly be bestowed on other camps and other earthworks than those on which attention is now so unfortunately concentrated.

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## BRISTLE-TAILS AND SPRING-TAILS.

BY A. S. PACKARD, JR., M.D.

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THE Thysanura, as the Poduras and their allies, the Lepismas, are called, have been generally neglected by entomologists, and but few naturalists have paid special attention to them.\* Of all those microscopists who have examined Podura scales as test objects, we wonder how many really know what a Podura is?

In preparing the following account I have been under constant indebtedness to the admirable and exhaustive papers of Sir John Lubbock, in the London Linnæan Transactions (vols. 23, 26 and 27). Entomologists will be glad to learn that he is shortly going to press with a volume on the Poduras, which, in distinction from the Lepismas, to which he restricts the term Thysanura, he calls Collembola, in allusion to the sucker-like tubercle situated on the under side of the body, which no other insects are known to possess.

The group of Bristle-tails, as we would dub the Lepismas in distinction from the Spring-tails, we will first consider. They are abundant in the Middle States under stones and leaves in forests, and northward are common in damp houses, while one beau-

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\* Nicolet, in the "Annales de la Societe Entomologique de France" (tome v, 1847), has given us the most comprehensive essay on the group, though Latreille had previously published an important essay, "De l'Organisation Exterieur des Thysanoures" in the "Nouvelles Annales du Museum d'Histoire Naturelle Paris, 1832," which I have not seen. Gervais has also given a useful account of them in the third volume of "Ap-teres" of Roret's Suite a Buffon, published in 1844.

The Abbe Bourlet, Templeton, Westwood, and Haliday have published important papers on the Thysanura; and Meinert, a Danish naturalist, and Olfers, a German anatomist, have published important papers on the anatomy of the group. In this country Say and Fitch have described less than a dozen species, and the writer has described a new species of Campodea, while Humbert has described in a French scientific journal a species of Japyx (*J. Saussurii*) from Mexico.

tiful species that we have never noticed elsewhere, is our "cricket on the hearth," abounding in the chinks and crannies of the range of our house, and coming out like cockroaches, at night, shunning the light. Like the cockroaches, which they vaguely resemble in form, this species loves hot and dry localities, in distinction from the others which seek moisture as well as darkness. By some they are called "silver witches," and as they dart off, when disturbed, like a streak of light, their bodies being coated in a suit of shining mail, which the arrangement of the scales resembles, they have really a weird and ghostly look.

The *Lepisma saccharina* of Linnæus, if, as is probable, that is the name of our common species, is not uncommon in old damp houses, where it has the habits of the cockroach, eating cloths, tapestry, silken trimmings of furniture, and doing occasional damage to libraries by devouring the paste, and eating holes in the leaves and covers of books.

In general form *Lepisma* may be compared to the larva of *Perla*, a net-veined Neuropterous insect, and also to the narrow-bodied species of cockroaches, minus the wings. The body is long and narrow, covered with rather coarse scales, and ends in three many-jointed anal stylets, or bristles, which closely resemble the many-jointed antennæ, which are remarkably long and slender. The thermophilous species already alluded to may be described as perhaps the type of the genus, the *L. saccharina* being simpler in its structure. The body is narrow and flattened; the basal joints of the legs being broad, flat and almost triangular, like the same joints in the cockroaches. The legs consist of six joints, the tarsal joints being large and two in number, and bearing a pair of terminal curved claws. The three thoracic segments are of nearly equal size, and the eight abdominal segments are also of similar size. The tracheæ are well developed, and may be readily seen in the legs. The end of the rather long and weak abdomen is propped up by two or three pairs of bristles, which are simple, not jointed, but moving freely at their insertion; they thus take the place of legs, and remind one of the abdominal legs of the *Myriapods*; and we shall see in certain other genera (*Machilis* and *Cam-podea*) of the Bristle-tails that there are actually two-jointed bristles arranged in pairs along the abdomen. They may probably be directly compared with the abdominal legs of *Myriapods*. Further study, however, of the homologies of these peculiar appendages,

and especially a knowledge of the embryological development of *Lepisma* and *Machilis*, is needed before this interesting point can be definitely settled. The three many-jointed anal stylets may, however, be directly compared with the similar appendages of *Perla* and *Ephemera*. The mode of insertion of the antennæ of this family is much like that of the *Myriapods*, the front of the head being flattened, and concealing the base of the antennæ, as in the *Centipedes* and *Paupopus*. Indeed the head of any *Thysanurous* insect seen from above, bears a general resemblance in some of its features to that of the *Centipede* and its allies. So in a less degree does the head of the larvæ of certain *Neuroptera* and *Coleoptera*. The eyes are compound, the single facets forming a sort of heap. The clypeus and labrum, or upper lip, is, in all the *Thysanura*, carried far down on the under side of the head, the clypeus being almost obsolete in the *Poduridæ*, this being one of the most essential characters of that family. Indeed, it is somewhat singular that these and other important characteristics of this group have been almost entirely passed over by authors, who have consequently separated these insects from other groups on what appear to the writer as comparatively slight and inconsiderable characters. The mouth-parts of the *Lepismatidæ* (especially the thermophilous *Lepisma*, which we now describe) are most readily compared with those of the larva of *Perla*.

Fig. 23.



The rather large, stout mandibles are concealed at their tips, under the upper lip, which moves freely up and down when the creature opens its mouth. The mandible is about one third as broad as long, armed with three sharp teeth on the outer edge, and with a broad cutting edge within, and still further within, a lot of straggling spinules. In all these particulars, the mandible of *Lepisma* is comparable with that of certain *Coleoptera* and *Neuroptera*. So also are the maxillæ and labium, though we are not aware that any one has indicated how close the homology is. The accompanying figure (23) of the maxilla of a beetle may serve as an example of the maxilla of the *Coleoptera*, *Orthoptera*, and *Neuroptera*. In these insects it consists invariably of three lobes, the outer being the palpus, the middle lobe the galea, and the innermost the lacinia; the latter undergoing the greatest modifications, forming a comb composed of spines and hairs varying greatly in relative size and length. How much the

palpi vary in these groups of insects is well known. The galea sometimes forms a palpus-like appendage. Now these three lobes may be easily distinguished in the maxilla of *Lepisma*. The palpus instead of being directed forward, as in the insects mentioned above (in the pupa of *Ephemera* the maxilla is much like that of *Lepisma*), is inserted nearer the base than usual and thrown off at right angles to the maxilla, so that it is stretched out like a leg, and in moving about the insect uses its maxillæ partly as supports for its head. They are very long and large, and five or six-jointed. The galea, or middle division, forms a simple lobe, while the lacinia has two large chitinous teeth on the inner edge, and internally four or five hairs arising from a thin edge.

The labium is much as in that of *Perla*, being broad and short, with a distinct median suture, indicating its former separation in embryonic life into a pair of appendages. The labial palpi are three-jointed; the joints being broad, and in life directed backwards instead of forwards, as in the higher insects.

There are four American species of the genus *Lepisma* in the Museum of the Peabody Academy, which contains, so far as we are aware, the only collection, small as it is, of *Thysanura* in the country. Besides the common *L. saccharina*? (Pl. 1, fig. 1) there are three undescribed species; one the heat-loving form, perhaps an imported species, found in a kitchen in Salem, and apparently allied to the *L. thermophila* Lucas, of houses in Brest, France; and two allied forms, one from Key West, and another from Polvon, Western Nicaragua, collected by Mr. McNeil. These three last species are beautifully ornamented with finely spinulated hairs arranged in tufts on the head; while the sides of the body, and edges of the basal joints of the legs are fringed with them.

The most complicated genus, and which stands at the head of the family, is *Machilis* (Pl. 1. figs. 8, 9), of which there are specimens in the Museum of the Peabody Academy, from Albany, N. Y., Virginia, and Oregon, indicating two species. They affect dry places, living under leaves and stones. They all have rounded, highly arched bodies, and large compound eyes, the pair being united together. The maxillary palpi are greatly developed; but the chief characteristics are the two-jointed stylets arranged in nine pairs along each side of the abdomen, reminding us of the abdominal legs of *Myriapods*. The body ends in three long bristles, as in *Lepisma*. The interesting genus *Nicoletia* stands at the bot-

tom of the group. It has the long, linear, scaleless body of Campodea, in the family below, but the head and its appendages are like Lepisma, the maxillary palpi being five-jointed, and the labial palpi four-jointed. The eyes are simple, arranged in a row of seven on each side of the head. The abdomen ends in three long and many-jointed stylets, and there are the usual "false branchial feet" along each side of the abdomen. There are two European species which occur in green houses. No species have yet been found in America.

The next family of Thysanura is the Campodeæ, comprising the two genera, Campodea, and Japyx. These insects are much smaller than the Lepismidæ, and in some respects are intermediate between that family and the Poduridæ (including the Sminthuridæ).

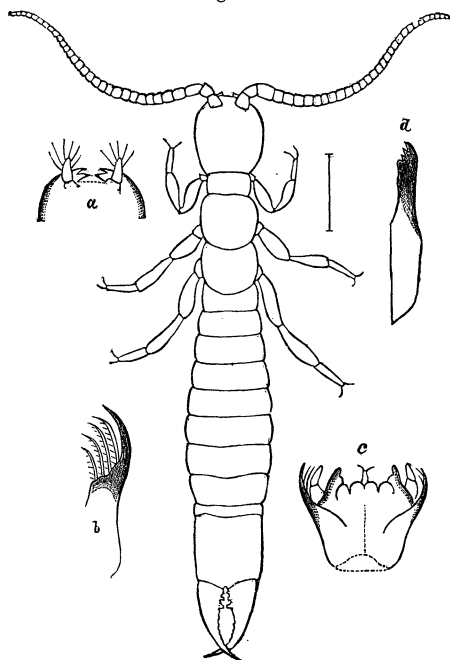
In this family the body is long and slender, and the segments much alike in size. There is a pair of spiracles on each thoracic ring. The mandibles are long and slender, ending in three or four teeth, and, with the other appendages of the mouth, are concealed within the head, "only the tips of the palpi (and of the maxillæ when these are opened) projecting a very little beyond the rounded entire margin of the epistoma," according to Haliday. The maxillæ are comb-shaped, due to the four slender, minutely ciliated spines placed within the outer tooth. The labium in Japyx is four-lobed and bears a small two-jointed palpus. The legs are five-jointed, the tarsi consisting of a single joint, ending in two large claws. The abdomen consists of ten segments, and in Campodea along each side is a series of minute, two-jointed appendages such as have been described in Machilis. These are wanting in Japyx. None of the species in this family have the body covered with scales.

The more complicated genus of the two is Japyx (Fig. 24, *Japyx solifugus* Hal. ; *a*, the mouth from beneath, with the maxillæ open ; *b*, maxilla ; *d*, mandible ; *c*, outline of front of head seen from beneath, with the labial palpi in position), which, as remarked by the late Mr. Haliday (who has published an elaborate essay on this genus in the Linnæan Transactions, vol. 24, 1864), resembles Forficula in the large forceps attached to its tail.

Campodea (*C. staphylinus* Westw., Fig. 25, enlarged ; *a*, mandible ; *b*, maxilla), otherwise closely related, has more rudimentary mouth-parts, and the abdomen ends in two many-jointed bristles.

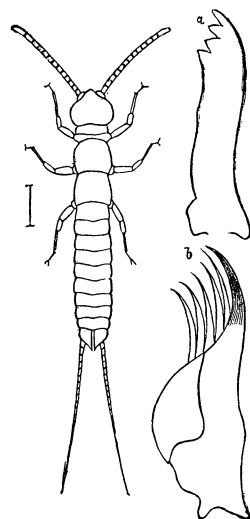
Our only American species of Campodea (*C. Americana* Pack.) lives under stones in damp places. It is yellowish, about a sixth of an inch in length, is very agile in its movements, and would easily be mistaken for a very young *Lithobius*. Haliday has remarked that this family bears much resemblance to the Neuropterous larva of *Perla*, as previously remarked by Gervais; and the many points of resemblance of this family and the Lepismidæ to the larval forms of those Neuroptera that are active in the pupa

Fig. 24.



Japyx.

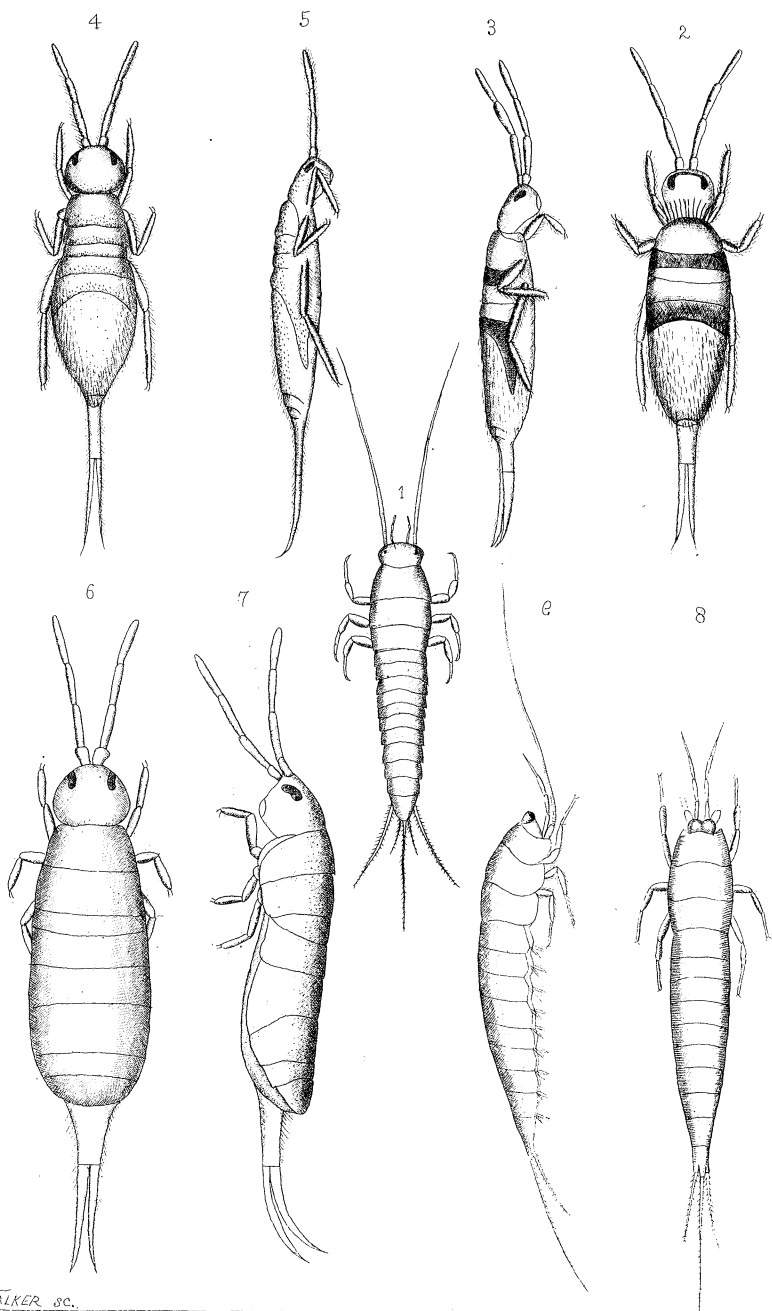
Fig. 25.



Campodea.

state (the Pseudo-neuroptera of Erichson and other authors) are very striking. Campodea resembles the earliest larval form of *Chloëon*, as figured by Sir John Lubbock, even to the single-jointed tarsus; and why these two Thysanurous families should be removed from the Neuroptera we are unable, at present, to understand, as to our mind they do not diverge from the Neuropterous type any more than the Mallophaga, or biting lice, do from the type of Hemiptera.

Haliday, remarking on the opinion of Linnæus and Schrank, who





referred Campodea to the old genus Podura, says with much truth, "it may be perhaps no unfair inference to draw, that the insect in question is in some measure intermediate between both." This is seen especially in the mouth-parts which are withdrawn into the head, and become very rudimentary, affording a gradual passage into the mouth-parts of the Poduridæ, which we now describe.

The next group, the Podurellæ of Nicolet, and Collembola of Lubbock, are considered by the latter, who has studied them with far more care than any one else, as "less closely allied" to the Lepismidæ "than has hitherto been supposed." He says "the presence of tracheæ, the structure of the mouth, and the abdominal appendage, all indicate a wide distinction between the Lepismidæ and the Poduridæ. We must, indeed, in my opinion, separate them entirely from one another; and I would venture to propose for the group comprised in the old genus Podura, the term Collembola, as indicating the existence of a projection, or mammilla, enabling the creature to attach or glue itself to the body on which it stands." Then without expressing his views as to the position and affinities of the Lepismidæ, he remarks "as the upshot of all this, then, while the Collembola are clearly more nearly allied to the Insecta than to the Crustacea or Arachnida, we cannot, I think, regard them as Orthoptera or Neuroptera, or even as true insects. That is to say, the Coleoptera, Orthoptera, Neuroptera, Lepidoptera, etc., are in my opinion, more nearly allied to one another than they are to the Poduridæ or Smynthuridæ. On the other hand, we certainly cannot regard the Collembola as a group equivalent in value to the Insecta. If, then, we attempt to map out the Articulata, we must, I think, regard the Crustacea and Insecta as continents, the Myriapoda and Collembola as islands — of less importance, but still detached. Or, if we represent the divisions of the Articulata like the branching of a tree, we must picture the Collembola as a separate branch, though a small one, and much more closely connected with the Insecta, than with the Crustacea or the Arachnida." Lamarck regarded them as more nearly allied to the Crustacea than Insecta. Gervais, also, in the "*Histoire Naturelles des Insectes : Aptères*," indicates a considerable diversity existing between the Lepismidæ and Poduridæ, though they are placed next to each other. Somewhat similar views have been expressed by so high an authority as Professor Dana, who, in the "*American Journal of Science*" (vol. 37, Jan., 1864), proposed a

classification of insects (based on the principle of cephalization), and divided the Hexapodous insects into three groups: the first (Ptero-prosthenics, or Ctenoptera) comprising the Hymenoptera, Diptera, Aphaniptera (Fleas), Lepidoptera, Homoptera, Trichoptera and Neuroptera; the second group (Ptero-metasthenics, or Elyptoptera) comprising the Coleoptera, Hemiptera and Orthoptera; while the Thysanura compose the third group. Lubbock has given us a convenient historical view of the opinions of different authors regarding the classification of these insects, which we find useful. Nicolet, the naturalist who, previous to Lubbock, has given us the most correct and complete account of the Thysanura, regarded them as an order, equivalent to the Coleoptera or Diptera, for example. In this he followed Latreille, who established the order in 1796. The Abbe Bourlet adopted the same view. On the other hand Burmeister placed the Thysanura as a separate tribe between the Mallophaga (Bird Lice) and Orthoptera, and Gerstaecker placed them among the Orthoptera. Fabricius and Blainville put them with the Neuroptera, and the writer, in his "Guide to the Study of Insects," and previously in 1863, ignorant of the views of the two last named authors, considered the Thysanura as degraded Neuroptera, and noticed their resemblance to the larvæ of *Perla*, *Ephemera*, and other Neuroptera, such as *Rhaphidia* and *Panorpa*, regarding them as standing "in the same relation to the rest of the Neuroptera [in the Linnæan sense], as the flea does to the rest of the Diptera, or the lice and Thrips to the higher Hemiptera."

After having studied the Thysanura enough to recognize the great difficulty of deciding as to their affinities and rank, the writer does not yet feel prepared to go so far as Dana and Lubbock, for reasons that will be suggested in the following brief account of the more general points in their structure, reserving for another occasion a final expression of his views as to their classification.

The Poduridæ, so well known by name, as affording the scales used by microscopists as test objects, are common under stones and wet chips, or in damp places, cellars, and about manure heaps. They need moisture, and consequently shade. They abound most in spring and autumn, laying their eggs at both seasons, though most commonly in the spring. During a mild December, such as just experienced, they may be found in abundance. Nearly a dozen species were found on the grounds of the Museum of the

Peabody Academy, affording ample material for study until nearly Christmas time, and again, late in February. About a hundred species are found in Europe, and nearly a quarter of that number I have, with the aid of my friend Mr. C. A. Walker, observed in this country, though paying little attention to them previous to last autumn.

The body of the Poduras is rather short and thick, most so in *Smynthurus* (Fig. 26), and becoming long and slender in *Tomocerus* and *Isotoma*. The segments are inclined to be of unequal size, the prothoracic ring sometimes becoming almost obsolete, and some of the abdominal rings are much smaller than others; while in *Anura* and *Lipura*, the lowest forms of the group, the segments are all much alike in size.

The head is, in form, much like that of certain larvæ of Neuroptera. The basal half of the head is marked off from the eye-bearing piece (epicranium) by a V-shaped suture (Fig. 28, head of *Degeeria*), and the insertion of the antennæ is removed far down the front, near the mouth, the clypeus being very short; this piece, so large and prominent in the higher insects, is not distinctly separated by suture from the surrounding parts of the head, thus affording one of the best distinctive characters of the Poduridæ. The eyes are situated on top of the head just behind the antennæ, and are simple, consisting of a group of from five to eight or ten united into a mass in *Smynthurus*, but separated in the Poduridæ (Fig. 41, *e*, eye of *Anura*). The antennæ are usually four-jointed, and vary in length in the different genera. The mouth-parts are very difficult to make out, but by soaking the insect in potash for twenty-four hours, thus rendering the body transparent, they can be satisfactorily observed. They are constructed on the same general type as the mouth-parts of the Neuroptera, Orthoptera, and Coleoptera, and except in being degraded, and with certain parts obsolete, they do not essentially differ. On observing the living Podura, the mouth seems a simple ring, with a minute labrum and groups of hairs and spinules, which the observer, partly by guess-work, can identify as jaws, and maxillæ, and labium. But in studying the parts rendered transparent, we can identify the different appendages. Fig. 29 shows the common *Tomocerus plumbeus* greatly enlarged, and as the mouth-parts of the whole group of Poduras are remarkably constant, a description of one genus will suffice for all. The labrum, or upper lip, is sepa-

rated by a deep suture from the clypeus, and is trapezoidal in form. The mandibles and maxillæ are long and slender, and buried in the head, with the tips capable of being extended out from the ring surrounding the mouth for a very short distance. The mandibles (*md*, Fig. 30) are like those of the Neuroptera, Orthoptera and Coleoptera, in their general form, the tip ending in from three to six teeth (three on one mandible and six on the other), while below (Fig. 41, *md*) is a rough, denticulated molar surface, where the food seized by the terminal teeth is triturated and prepared to be swallowed. Just behind the mandibles are the maxillæ, which are trilobate at the end, as in the three orders of insects above named. The outer lobe, or palpus, is a minute membranous tubercle ending in a hair (Fig. 31, *mp*), while the middle lobe, or galea, is nearly obsolete, though I think I have seen it in *Smynthurus* where it forms a lobe on the outside of the lacinia. The lacinia, or inner lobe (Fig. 31, *lc*; 32, the same enlarged), in *Tomocerus* consists of two bundles of spinules, one broad like a ruffle, and the other slender, pencil-like, ending in an inner row of spines, like the spinules on the lacinia of the Japyx and Campodea, and, more remotely, the lacinia of the three orders of insects above referred to. There is also a horny, prominent, three-toothed portion (Fig. 31, *g*). These homologies have never been made before, but they seem natural, and suggested by a careful examination and comparison with the above-mentioned mandibulate insects.

The spring consists of a pair of three-jointed appendages, with the basal joint soldered together early in embryonic life, while the two other joints are free, forming a fork. It is longest in *Smynthurus* and *Degeeria*, and shortest in *Achorutes* (Fig. 36, *b*), where it forms a simple, forked tubercle; and is obsolete in *Lipura*, its place being indicated by an oval scar. The third joint varies in form, being hairy, serrate and knife-like in form, as in *Tomocerus* (Fig. 30, *a*), or minute, with a supplementary tooth, as in *Achorutes* (Fig. 36, *c*). This spring is in part homologous with the ovipositor of the higher insects, which originally consists of three pairs of tubercles, each pair arising apparently from the seventh, eighth, and ninth (the latter the penultimate) segments of the abdomen in the Hymenoptera. The spring of the *Podura* seems to be the homologue of the third pair of these tubercles, and is inserted on the penultimate segment. This comparison I have been able to make from a study of the embryology of *Isotoma*.

Another organ, and one which, so far as I am aware, has been overlooked by previous observers, I am disposed to consider as an ovipositor. In the genus *Achorutes*, it may be found in the segment just behind the spring-bearing segment, and situated on the median line of the body. It consists (Fig. 36) of two squarish valves, from between which project a pair of minute tubercles, or blades, with four rounded teeth on the under side. This pair of infinitesimal saws, remind one of the blades of the saw-fly, and I am at a loss what their use can be unless to cut and pierce so as to scoop out a place in which to deposit an egg. It is homologous in situation with the middle pair of blades which compose the ovipositor of higher insects, and if it should prove to be used by the creature in laying its eggs, we should then have with the spring, an additional point of resemblance to the Neuroptera and higher insects, and instead of this spring being an important differential character, separating the Thysanura from other insects, it binds them still closer, though still differing greatly in representing only a part of the ovipositor of the higher insects.

But all the Poduras differ from other insects in possessing a remarkable organ situated on the basal segment of the abdomen. It is a small tubercle, with chitinous walls, forming two valves from between which is forced out a fleshy sucker, or, as in *Smynturus*, a pair of long tubes, which are capable of being darted out on each side of the body, enabling the insect to attach itself to smooth surfaces, and rest in an inverted position.

The eggs are laid few in number, either singly or several together, on the under side of stones, chips, or, as in the case of *Isotoma Walkerii* Pack., under the bark of trees. They are round, transparent. The development of the embryo of *Isotoma* in general accords with that of the Phryganeidæ and suggests the near relationship of the Thysanura to the Neuroptera.

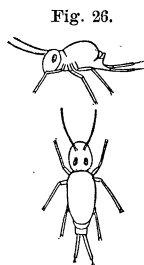
Sir John Lubbock has given us an admirable account of the internal anatomy of these little creatures, his elaborate and patient dissections filling a great gap in our knowledge of their internal structure. The space at our disposal only permits us to speak briefly of the respiratory system. Lubbock found a simple system of tracheæ in *Smynturus* which opens by "two spiracles in the head, opposite the insertion of the antennæ," *i. e.*, on the back of the head. (Von Olfers says, they open on the prothorax.) Nicolet and Olfers claim to have found tracheæ in several lower

genera (*Orchesella*, *Tomocerus*, and *Achorutès*, and allied genera), but Lubbock was unable to detect them, and I may add that I have not found them either in living specimens, or those rendered transparent by potash, though careful search was made for them.

Having given a hasty sketch of the external aspect of the *Poduras*, I extract from Lubbock a synopsis of the families and genera for the convenience of the student, with the names of known American species, or indications of undescribed native forms.

#### SMYNTHURIDÆ.

Body globular or ovoid; thorax and abdomen forming one mass; head vertical or inclined; antennæ of four or eight segments. Eyes eight on each side, on the top of the head. Legs long and slender. Saltatory appendage with a supplementary segment.



*Smynthurus*.

*Smynthurus* Latreille. Antennæ four-jointed, bent at the insertion of the fourth, which is nearly as long as the other three, and appears to consist of many small segments. No conspicuous dorsal tubercles. (In this country Fitch has described five species: *S. arvalis*, *elegans*, *hortensis*, *Novæboracensis*, and *signifer*. Fig. 26 represents a species found in Maine.)

*Dicyrtoma* Bourlet. Antennæ eight-jointed, five before, three after the bend. Two dorsal tubercles on the abdomen.

*Papirius* Lubbock.\* Antennæ four-jointed, without a well-marked elbow, and with a short terminal segment offering the appearance of being many-jointed.

#### PODURIDÆ.

This family comprises those species of the old genus *Podura*, in which the mouth has mandibles [also maxillæ and a labium], and the body is elongated, with a more or less developed saltatory appendage at the posterior extremity.

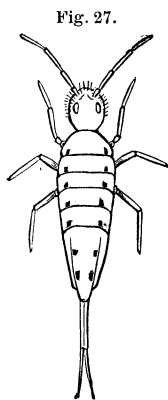
*Orchesella* Templeton. Segments of the body unequal in size,

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\*Lubbock considers that *Papirius* should be placed in a distinct family from *Smynthurus*, because it wants tracheæ. Their presence or absence scarcely seems to us to be a family character, as they are wanting in the *Poduridæ*, and are not essential to the life of these animals, while in other respects *Papirius* differs but slightly from *Smynthurus*.

more or less thickly clothed by clubbed hairs. Antennæ long, six-jointed. Eyes six in number on each side, arranged in the form of an S. (One or two beautiful species live about Salem.)

*Degeeria* Nicolet. Segments of the body unequal in size, more or less thickly clothed by clubbed hairs. Antennæ longer than the head and thorax, filiform, four-jointed. Eyes eight in number, on each side of the head. (Two species are figured on Pl. 1, figs. 2-5. Fig. 27 represents a species found in Salem, Mass., closely allied to the European *D. nivalis*. Fig. 28, head of a *Degeeria*, showing the parts of the head. Five species are already known in New England.)



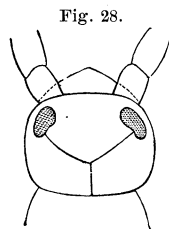
Degeeria.

*Seira* Lubbock. Body covered with scales. Antennæ four-jointed; terminal segment not ringed. Eyes on a dark patch. Thorax not projecting over the head. Abdominal segments unequal.

*Templetonia* Lubbock. Segments of the body subequal, clothed by clubbed hairs, and provided with scales. Antennæ longer than the head and thorax, five-jointed, with a small basal segment, and with the terminal portion ringed.

*Isotoma* Bourlet (*Desoria* Nicolet). Four anterior abdominal segments subequal, two posterior ones small; body clothed with simple hairs, and without scales. Antennæ four-jointed, longer than the head; segments subequal. Eyes seven in number on each side, arranged in the form of an S. (Three species are found in Massachusetts, one of which is figured on Pl. 1, figs. 6, 7.)

*Tomocerus* Nicolet. Abdominal segments unequal, with simple hairs and scales. Antennæ very long, four-jointed, the two terminal segments ringed. Eyes seven in number on each side. (The European *T. plumbea* Linn., *Podura plumbea* of authors, is one of our most common species. Fig. 29, greatly enlarged, copied from Templeton; fig. 30, side view, see also fig. 31, where the mouth-parts are greatly enlarged, the lettering being the same, *md*, mandibles; *mx*, maxillæ; *mp*, maxillary palpus; *lb*, labium; *lp*, labial palpus; *lc*, lacinia; *g*, portion ending in three teeth; *l*, lobe of labium; *sp*,



Head of *Degeeria*.

Fig. 30.

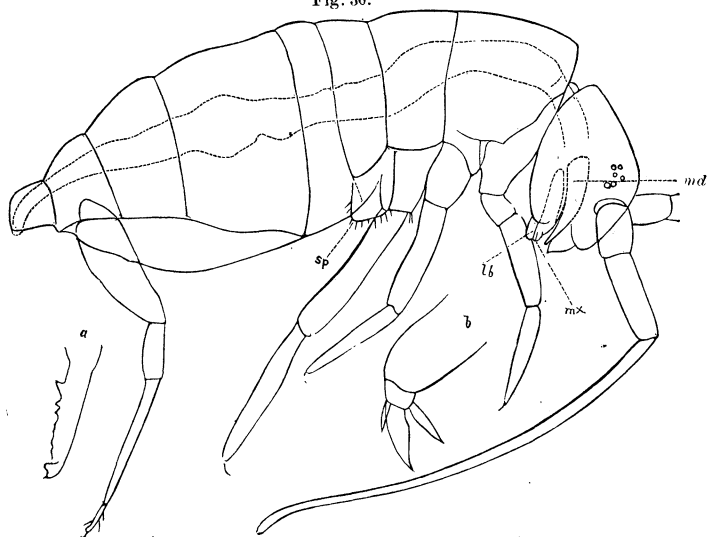


Fig. 29.

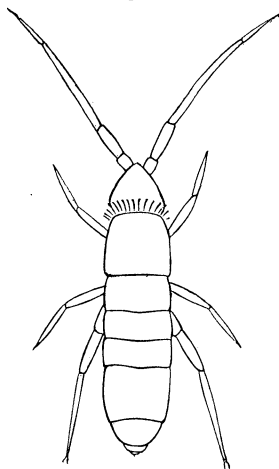


Fig. 33.

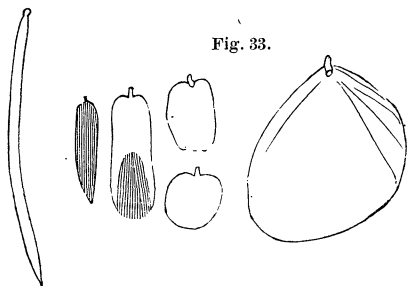


Fig. 31.

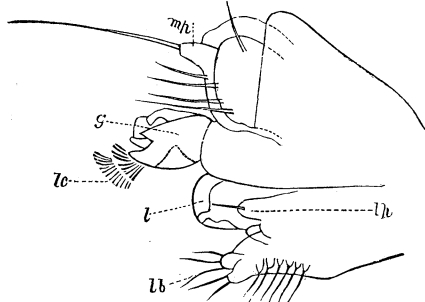
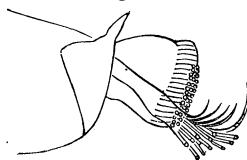


Fig. 32.

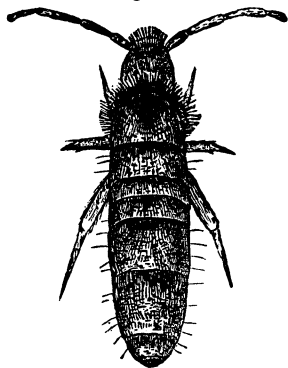


*Tomocerus Plumbeus.*



ventral sucking disc; the dotted lines passing through the body represent the course of the intestine; *b*, end of tibia, showing the tarsus, with the claw, and two accessory spines; *a*, third joint of the spring. Fig. 32, lacinia of maxilla greatly enlarged. Fig. 33, different forms of scales, showing the great variation in size and form, the narrow ones running into a linear form, becoming hairs. The markings are also seen to vary, showing their unreliable character as test objects, unless a single scale is kept for use.)

Fig. 34.

*Lepidocyrtus albinos*.

*Lepidocyrtus* Bourlet. Abdominal segments unequal, with simple hairs and scales. Antennæ long, four-jointed. Eyes eight in number on each side. (Fig. 34, *L. albinos*, an European species, from Hardwicke's "Science Gossip." Fig. 35, a scale. Two species in New England.)

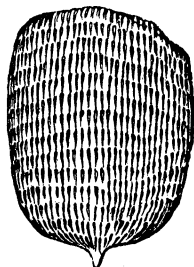
*Podura*. Abdominal segments subequal. Hairs simple, no scales. Antennæ four-jointed, shorter than the head. Eyes eight in number on each side. Saltatory appendage of moderate length.

*Achorutes* Templeton. Abdominal segments subequal. Antennæ short, four-jointed. Eyes eight in number on each side. Saltatory appendage quite short.

Fig. 36 represents a species of this genus very abundant under the bark of trees, etc., in New England. It is blackish lead color; *a*, end of tibia bearing a tenant hair, with the tarsal joint and large claw; *b*, spring; *c*, the third joint of the spring, with the little spine at the base; fig. 37, the supposed ovipositor; *a*, the two blades spread apart; *b*, side view. The mouth-parts in this genus are much as in *Tomocerus*, the maxillæ ending in a lacinia and palpus.

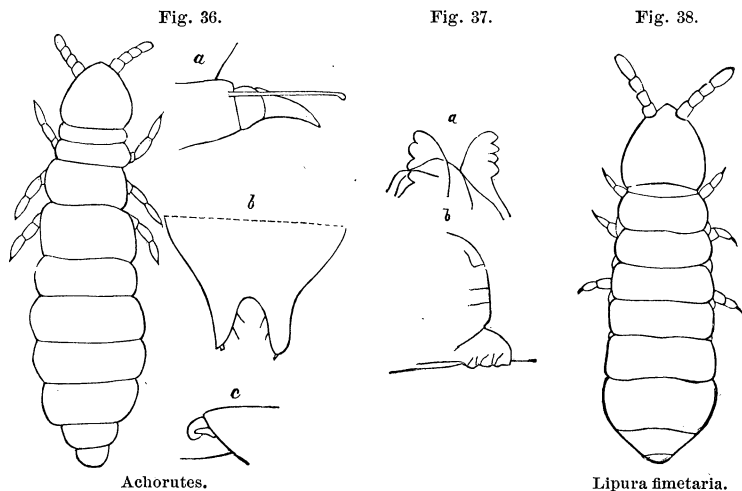
The two remaining genera, *Lipura* and *Anura*, are placed in the "family" Lipuridæ, which have no spring. Lubbock remarks that "this family contains as yet only two genera, *Lipura* (Burmeister), in which the mouth is composed of the same parts as those in the preceding genera, and *Anura* (Gervais), in which the mandibles

Fig. 35.



and maxillæ disappear." Our common white *Lipura* is the European *L. fimetaria* Linn. (fig. 38, copied from Lubbock). The site of the spring is indicated by an oval scar.

Fig. 39 represents a common species of *Anura* found under stones between tide marks at Nantucket. Compared with *Achorutes*, the body is rather longer and slenderer and more hairy, while the front of the head is much prolonged, almost forming a beak. The legs (fig. 40) end in a large, long, curved claw. On examin-



ing specimens soaked in potash, I have found that the mouth-parts (fig. 41, *md*, mandibles; *mx*, maxillæ; *e*, eyes, and a singular accessory group of small cells, which have not been noticed heretofore as far as I am aware) are exactly like those of *Achorutes* and *Lipura*. The mandibles, like those of other Poduras, end in from three to six teeth, and have a broad, many-toothed molar surface below. The maxillæ end in a tridentate lacinia as usual, though the palpi and galea I have not yet studied.

For the reason that I can find no valid characters for separating these two genera as a family from the other Poduras, I am inclined to think that they form, by the absence of the spring, only a sub-division (perhaps a sub-family) of the Poduridæ.

The best way to collect Poduras is, on turning up the stick or stone on the under side of which they live, to place a vial over them, allowing them to leap into it; they may be incited to

leap by pushing a needle under the vial. They may also be collected by a bottle with a sponge saturated with ether or chloroform. They may be kept alive in vials for weeks by keeping moist slips of blotting paper in the vial. In this way I have kept specimens of *Degeeria*, *Tomocerus* and *Orchesella*, from the middle of December till late in January. During this time they occa-

Fig. 41.

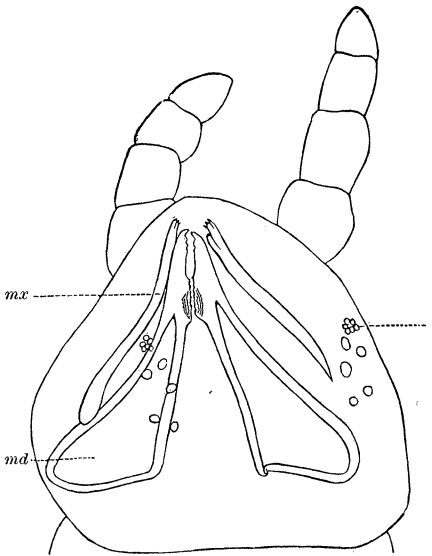


Fig. 39.

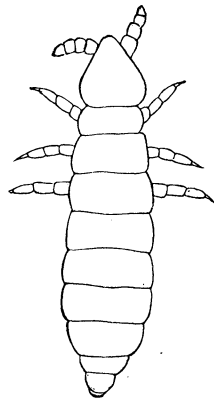


Fig. 40.



## Anura.

sionally moulted, and *T. plumbea*, after shedding its skin eat it up within a few hours. Poduras feed ordinarily on vegetable matter, such as dead leaves and growing cryptogamic vegetation.

These little creatures can be easily preserved in a mixture of whiskey and glycerine, or pure whiskey, though without the glycerine the colors fade. The writer would be thankful for specimens both of Poduras and Lepismas, for study.